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BONE FUSION ACCELERATING DEVICE

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Claims

1. Bone fusion acceleration device equipped with a high frequency generator characterized by the fact that a supply electrode which is connected to one output terminal of the aforementioned high frequency generator and several receiving electrodes which are connected to the other output terminal of the aforementioned high frequency generator are provided.

2. Bone fusion acceleration device in accordance with Claim 1 characterized by the fact a variable output level means with which the output level between the aforementioned supply electrode and each receiving electrode can vary individually is provided.

3. Bone fusion accelerating device in accordance with either Claim 1 or 2 characterized by the fact that a memory means which stores the output level between the supply electrode and each receiving electrode which is obtained based on the bioimpedance at each part of the body and a reading means which reads the data which is stored in the memory means are provided.

Detailed explanation of the invention

Industrial application field

The present invention pertains to a bone fusion accelerating device which accelerates the fusion in fracture treatment.

Prior art

Conventionally, bone fusion accelerating devices which are used in fracture treatment that have been developed are based on the following methods: Direct current electrical stimulation method, alternating current electrical stimulation method, pulse electromagnetic field stimulation (PEMF) Plusing [sic] Electro-Magnetic Feilds [sic] method, and capacitative induction (CCEF: capacitively coupled electric field) method.

In a bone fusion accelerating device by the direct current electrical stimulation method or alternating current electrical stimulation method, two electrodes are inserted near the fractured part, and electric current is allowed to flow between them. In a bone fusion accelerating device by pulsing electric field stimulation method, a pulsing electric field is irradiated from outside of the body toward the fractured part; thus, dielectric current is generated at the fracture part. In a bone fusion accelerating device by the capacitative induction method, two electrodes are installed on the skin around the fractured part and high frequency is impressed between these.

Problems to be solved by the invention

Among the aforementioned conventional bone fusion accelerating devices, those with direct or alternating-current stimulation have the advantage of being able to concentrate electric stimulation energy at the fractured part because the electrodes are directly inserted into the organism as mentioned above. However, the drawback is the fact that, since electrodes are inserted into the organism, the patient will suffer physical pain. Meanwhile, those with pulsing electric field stimulation or capacitative induction have the advantage that the stress on the patient is light because the electrodes do not need to be inserted into the organism. However, the problems are that concentrating the electric stimulation energy efficiently at the fractured part is difficult, and that a longer period is needed for the formation of temporary bone or bone fusion.

The present invention is made considering the aforementioned situation. The purpose is to offer a bone growth accelerating device which is noninvasive, and can form temporary bones or fuse bones in a short period.

Means for solving the problems

The invention described in Claim 1 is characterized by the fact that it is a bone fusion accelerating device equipped with a high frequency generator with both a supply electrode which is connected to one output terminal of the aforementioned high frequency generator and several receiving electrodes which are

connected to the other output terminal of the aforementioned high frequency generator.

The invention described in Claim 2 is characterized by the fact that, in addition to the construction of the invention described in Claim 1, a variable output level means which allows the output level between the aforementioned supply electrode and each receiving electrode to vary individually is also provided.

The invention described in Claim 3 is characterized by the fact that, in addition to the construction of the invention which is described in either Claim 1 or 2, a memory means which stores the output level between the supply electrode and each receiving electrode, which is obtained based on the bioimpedance at each part of the body, and a reading means which reads the data which is stored in the memory means are provided.

Function

By means of the aforementioned construction, by providing several receiving electrodes to a supply electrode, each of the receiving electrodes can be arranged on the skin in a manner that surrounds the fractured part with the supply electrode in the center. Therefore, electrical stimulation energy can be effectively concentrated on the fractured part.

Also, because the output level between the supply electrode and each receiving electrode can be varied individually by means of the variable output level means, the imbalance of electric stimulation caused by the difference in bioimpedance due to the difference in the arrangement of each receiving electrode can be corrected.

Also, by providing the memory means, which stores the output level between the supply electrode and each receiving electrode at each part of the body, and the reading means which reads the data which is stored in this memory means, the optimum output level at each part of the body will be automatically set without adjustment of the aforementioned variable output level means.

Application examples

Application examples of the present invention will be explained next in reference to the figures.

Figure 1 is a schematic structural diagram which illustrates the bone fusion accelerating device by an application example of the present invention. The bone fusion accelerating device in the present application example adopts the aforementioned capacitative induction method.

In this figure, (1) is the high frequency generating part, which generates the high frequency of 60 kHz. The output level can be arbitrarily adjusted within the range of 2.5-10 V_{pp}. The frequency can also be varied arbitrarily. (2) is the control part, which is composed of a CPU (central processing unit), not illustrated, ROM (read only memory), ROM [sic; RAM] (random access memory), interface, multiplexer, etc. A program for controlling the CPU is written in the aforementioned ROM. When a treatment starting switch which is not illustrated is turned on, this control part (2) reads the output of selector switch (3) according to the program which is written in the ROM, selects either the memory part (4) or the manual setting part (5) based

on the set value, and reads the output value. It has the function of adjusting the output level between the supply electrode (6A) and each of the receiving electrodes ($6B_1$-$6B_n$) based on the output value which is read. In the aforementioned memory part (4), the output level (data) between the supply electrode and each receiving electrode based on the bioimpedance at each part of the body is written. Each datum is selected by the selector part (7). Meanwhile, the manual setting part (5) allows the output level between the supply electrode (6A) and each of the receiving electrodes ($6B_1$ ~$6B_n$) to be manually adjustable. As many variable resistors as the number of receiving electrodes ($6B_1$-$6B_n$) are provided. Here, the reason the memory part (4) and the manual setting part (5) are provided is as follows: That is, when high frequency is impressed on the fractured part through the skin, fat, muscle, etc., of the human organism, because the distance between the supply electrode (6A) and each of the receiving electrodes ($6B_1$-$6B_n$) is different for each one, the electrical stimulation between each electrode will not be constant due to the different distances. There will be an imbalance as a whole. To correct such an imbalance, the memory part (4) or the manual setting part (5) is provided. (8) is the power source part which supplies power to each part of the device.

In the bone fusion accelerating device which is constructed in this manner, when the data in the memory part (4) is used, first the selector switch (3) is set to automatic, and then the setting of the selector part (7) is done, corresponding to the fractured part. Then, according to the arrangement of the data

according to the time it data was written in the memory part (4), both the supply electrode (6A) and receiving electrodes ($6B_1$-$6B_n$) are arranged on the skin at the fractured part. In this case, for instance, as illustrated in Figure 2, the supply electrode (6A) is placed, and the receiving electrodes ($6B_1$-$6B_n$) (n = 7 in this figure) are arranged opposite this supply electrode (6A). Then, after the arrangement of each of the electrodes (6A, $6B_1$-$6B_n$) is completed, the treatment start switch, which is not illustrated, is turned on. In this manner, the control part (2) will read the setting of the selector switch (3), and choose either automatic or manual mode based on the information. In this case, because it is in an automatic mode, the control part (2) reads the setting of the selector part (7), and reads the data corresponding to this setting from the memory part (4). Then, based on this data, high frequency is impressed between the supply electrode (6A) and each of the receiving electrodes ($6B_1$-$6B_n$).

Then, when the manual setting part (5) is used, the supply electrode (6A) and receiving electrodes ($6B_1$-$6B_n$) are arbitrarily arranged on the skin at the fractured part. After the arrangement of each of the electrodes (6A, $6B_1$-$6B_n$) is completed, the treatment start switch is turned on. In this manner, the control part (2) will determine that it is in a manual mode based on the setting of the selector switch (3), and reads the set value of each variable resistor of the manual setting part (5) by a predetermined sampling cycle. Then, based on the set value of each variable resistor at the time of reading, high frequency is impressed between the supply electrode (6A) and each of the

receiving electrodes ($6B_1$-$6B_n$). In the present case, using either X-ray CT (Computed [sic; Computerized] Tomography) or an ultrasound image diagnostic device, the supply electrode (6A) and receiving electrodes ($6B_1$-$6B_n$) are appropriately arranged based on the fault image around the infected area, and the output level of each can be set.

In this manner, several receiving electrodes ($6B_1$-$6B_n$) are provided for one supply electrode (6A), and the high frequency to be impressed between the supply electrode (6A) and each of the receiving electrodes ($6B_1$-$6B_n$) is determined. Thus, electrical stimulation energy can be efficiently provided to the fractured part.

In the aforementioned application example, both automatic mode and manual mode were provided. However, it is all right to provide only either one of them. In such a case, control elements such as the CPU are not always needed.

Effect of the invention

As explained above, since the present invention is constructed as mentioned above, the following effect is realized.

In the bone fusion accelerating device described in Claim 1, since a supply electrode which is connected to one output terminal of this high frequency generator and several receiving electrodes that are connected to the other output terminal of said high frequency generator are provided, electrical stimulation energy can concentrate at the fractured part.

Therefore, the formation of temporary bones and bone fusion can be carried out in a short period.

In the bone fusion accelerating device described in Claim 2, in addition to the construction described in Claim 1, an variable output level means which can individually vary the output level between the supply electrode and each receiving electrode is provided. Thus, the imbalanced electrical stimulation due to the different distances between the supply electrode and each of the receiving electrodes can be manually corrected.

In the bone fusion accelerating device described in Claim 3, in addition to the construction described in Claim 1 or 2, a memory means which stores the output level between the supply electrode and each of the receiving electrodes obtained based on the bioimpedance at each part of the body and a reading means which reads the data which is stored in this memory device, are provided. Thus, the imbalanced electrical stimulation due to the different distances between the supply electrode and each of the receiving electrodes at each part of the body, which is stored in the memory device, can be automatically corrected.

Brief explanation of the figures

Figure 1 is a schematic structural diagram which illustrates a bone fusion accelerating device which is an application example of the present invention. Figure 2 is a diagram for explaining how to use the same application example.

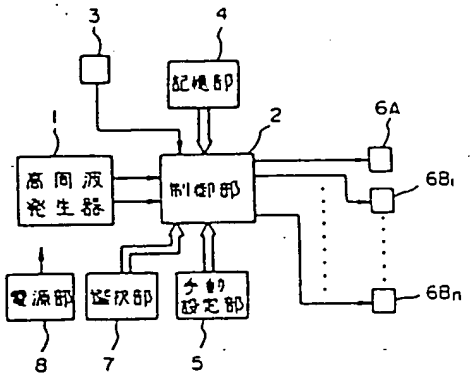

Figure 1

Key:
1 High frequency generator
2 Control part (reading means)
3 Selector switch
4 Memory part (memory means)
5 Manual setting part (variable output level means)
6A Supply electrode
$6B_1$-$6B_n$ Receiving electrodes
7 Selector part
8 Power source

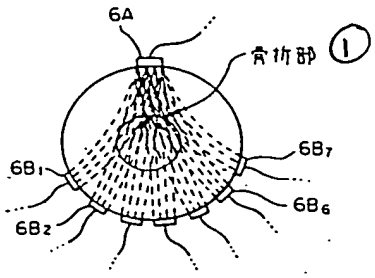

Figure 2

Key: 1 Fracture part